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Evaluation of magpie predation on the ring-necked pheasant

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AN EVALUATION OF MAGPIE PREDATION ON THE RING-NECKED PHEASANT

by

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INTRODUCTION

In 1956 and 1957 Brown (1957) determined the population density of nesting magpies (Pica pica hudsonia) in a 6 square mile area of the Burnt Fork Valley 1 mile east of Stevensville, Montana and evaluated the natural regulating mechanisms operating on this population. This represented the first phase of a long-range study during which the role of the magpie as a predator on ring-necked pheasants (Phasianus colchicus torquatus) is to be evaluated.

With knowledge of magpie nesting density and of natural controls operating on this potential predator it became feasible to study the extent of predation of the magpie population on a pheasant population. In order to determine the predatory effect of magpies, the reproductive rate, hatching success, and productivity of the pheasant had to be ascertained in an area where magpies are abundant. Thus this second phase was basically an investigation which covered the nesting of ring-necked pheasants.

The major objectives of this study were:

1. To determine the natality, mortality, and productivity of the ring-necked pheasant in the Burnt Fork area.

2. To evaluate pheasant mortality factors.

3. To determine the predatory effect of a known-density magpie population on a pheasant population.

DESCRIPTION OF THE STUDY AREA

The Burnt Fork study area is located in the Bitterroot Valley 1 mile east of Stevensville, Montana. It is composed of 6 square miles of ranch and farmland, bordered on the north and south by terraces (benches) rising abruptly 150-200 feet above the valley floor. The Bitterroot Valley proper abuts the area on the west and the east boundary is the western terminus of a sagebrush (*Artemisa tridentata*) flat.

Land Use. The residents depend, to varying degrees, upon raising livestock; consequently, over 90 per cent of the 6 square miles is utilized for pasturage and the production of alfalfa, wild hay, and grain. Irrigation is a necessity due to the lack of summer precipitation (Table I) and the porous nature of the soil. This results in numerous small diversion canals being present throughout the area accompanied by many drainage streams which are fed by springs and seepage.

Climate. The climate of the Burnt Fork area is typified by dry summers and usually mild winters (Maughan, 1941). Precipitation falls mainly in the spring and fall months (Table I) with a total yearly average of about 13 inches (Maughan, *op.*

TABLE I

CLIMATOLOGICAL SUMMARY[1]

OBSERVATIONS MADE AT STEVENSVILLE WEATHER STATION ONE MILE WEST OF STUDY AREA

	Temperature				Precipitation			
	1958		1959		1958		1959	
Month	Mean	Departure[3]	Mean	Departure[4]	Total & Departure[3]		Total & Departure[4]	
Jan.	28.8	5.7	28.7	5.6	0.49	-.57	1.50	0.44
Feb.	35.9	8.0	25.5	-2.4	1.11	0.11	1.57	0.57
March	*	*	38.5	2.9	*	*	0.68	-.17
April	43.9	-1.4	46.1	0.8	1.41	0.68	0.29	0.29
May	59.6	6.8	49.1	-3.7	1.69	0.22	2.97	1.50
June	61.3	2.7	61.5	2.9	3.31	1.57	1.30	-.44
July	64.9	-.9	65.5	-.3	1.92	0.99	0.08	-.85
Aug.	67.2	3.5	*	*	0.47	-.19	*	*
Sept.	55.2	0.1	*	*	0.61	-.32	*	*
Oct.	*	*	*	*	*	*	*	*
Nov.	34.4	1.0	*	*	1.92	0.79	*	*
Dec.	31.7	5.1	*	*	0.94	-.29	*	*

[1]Table arranged after that of Brown (1957).

[2]Daily observations made at 6 P.M., M.S.T.

[3]Departure from 44 year monthly temperature mean or 46 year monthly precipitation mean.

[4]Departure from 45 year monthly temperature mean or 47 year monthly precipitation mean.

*No data available.

cit.). Snow cover is usually present during some portions of December, January, February, and March (Table II). The average date of the first killing frost is September 15 and the last is May 25. Temperature extremes during the study from January 1, 1958 through August 31, 1959 were: 1958 - high 95°, low 1° and 1959 - high 97°, low -10°.

Vegetation. Year round cover is afforded largely by a brush-tree riparian complex (Alnus tenuifolia, Crataegus Douglasi, Prunus sp., Salix sp., and Rosa sp.). Variations of this complex are common throughout the area. Alfalfa, hay, and grain crops add to the late spring, summer, and early fall cover. Fencerows supporting wild rose (Rosa sp.), snowberry (Symphoricarpos sp.), goldenrod (Solidago sp.), and various grasses are present but not common. Some clear-cutting of fencerows is practiced.

Lauckhart and McKean (1956) divide the pheasant habitat of the northwest into 3 classes:

1. Diversified farming areas where the main crops are alfalfa, wheat, potatoes, sugarbeets, and corn.
2. Land used chiefly for livestock production.
3. Fruit orchards.

The Burnt Fork study area is obviously in class 2 and although this type is generally listed as rather poor pheasant habitat, Lauckhart and McKean (op. cit.) stipulate, "There is good pheasant production in this type when the birds utilize

TABLE II

SNOW ACCUMULATION IN THE BURNT FORK VALLEY[1]

Month	Maximum Snow Depth[2] (inches) 1958	1959	No. Days With Snow Cover[2] 1958	1959
January	0	3.0	0	7
February	3.0	14.0	10	24
March	*	1.3	*	2
December	2.0	*	6	*

[1]Data from Climatological Data Bulletins, U. S. Department of Commerce Weather Bureau.

[2]Observations made at Stevensville Weather Station one mile west of study area at 6 P.M., M.S.T.

*No data available.

brushlined water courses and marshy drainage areas." Pheasants in the Burnt Fork Valley do use this type habitat but as will be shown the pheasant density is only fair.

For a more detailed description of the study area the reader is referred to Brown (1957).

DETERMINATION OF BREEDING POPULATIONS

Pheasant. To attain the primary objective of this study it was necessary to determine the pheasant breeding population, for this is the basic stock with reference to which pheasant natality, mortality, and productivity will be computed. Two closely related steps were used to ascertain the wild pheasant breeding population: winter flush counts and crowing cock counts.

Winter Flush Counts For Determining The Sex Ratio. To secure a sex-ratio winter flush counts were made in both years during January and February. These counts were accomplished with the assistance of a Labrador retriever in 1958 and a German short-haired pointer in 1959. The birds were sought on the roosts at daylight or shortly after. Because of the mild winters (Tables I and II) the birds seldom were in aggregations larger than 5 or 6 individuals; therefore midday flushing was also necessary. The study area was covered, section by section, 3 times each winter, and from these data a sex ratio was determined.

Sex Ratio. Table III illustrates the manner in which the wild pheasant breeding population was calculated, i.e., the sex ratio was established from winter flush counts and the female contingent was determined by relating this ratio to the total number of crowing cocks. It was assumed hens and cocks flushed in equal proportions and all cocks crowed. The late winter sex ratios of the Burnt Fork wild breeding population (1958, 1 male:2.4 females, 1959, 1 male:2.1 females) are lower than those found by Craighead and Craighead (1956) in Michigan in 1942 and 1948 (1 male:4 females), and Stokes (1956) on Pelee Island during 1947 through 1951 (from 1 male:7.3 females to 1 male:9.6 females) but are similar to the ratios of Linduska (1947) in Michigan and Weston (1954) in Iowa which are: 1 male:2.1 females and 1 male:2.5 females, respectively. In Montana during the mid-and late-1940's Kimball et al., (1956) list data from which a 1 male:2.7 female ratio may be extracted.

TABLE III

DETERMINATION OF WILD PHEASANT BREEDING POPULATION

Year	1958	1959
Total No. Pheasants Censused In Winter Flush Counts	336	431
Sex Ratio (M:F)	1:2.4	1:2:1
Total No. Crowing Cocks	52	59
Calculated Wild Hen Population[1]	125	124
Total Wild Pheasants In Early April[2]	177	183
Pheasants Per Square Mile	30	31

[1]Derived from sex ratio mult. by crowing cock count.

[2]Total number crowing cocks plus calculated wild hen population.

Crowing Cock Counts. Throughout the country crowing cock counts are often based on the method developed by Kimball (1949) where established routes, 20 miles long, are driven for 1.5 hours each morning and 2 minute listening and recording stops are made at 1 mile intervals. This method is considered not sufficiently accurate for small study areas. On the Burnt Fork each crowing cock was assumed to be territorial and its location was noted on a field map, either directly or by triangulation. Its general location was checked during consecutive days so that finally a total count of all crowing cocks was accomplished. This census was carried on by foot from a half hour prior to sunrise until about an hour after sunrise from late March until mid-April.

Population Density. The prenesting season density in the Burnt Fork Valley was calculated to be 30 birds per square mile in 1958 and 31 birds in 1959 (Table III). These population figures are considerably under a 5 year average (1947-1951) of 173 birds per square mile in eastern Oregon and a 5 year average in central Washington of 96 birds per square mile (Lauckhart and McKean, 1956). They are similar, however, to those for south-eastern Washington where the same 5 year average listed 40 birds per square mile. The pheasant habitat in the Burnt Fork Valley is of only mediocre quality and the pheasant density bears this out.

Magpie Nesting Census. "Because predation is essentially a relation of population numbers, counts of both predator and prey are necessary to the understanding of this phenomenon" (Craighead and Craighead, 1956). Thus in a long term study such as the present one, periodic checks are made to inform the investigator of any appreciable changes of predator density.

Brown (1957) defined an active magpie nest as the presence of a nesting pair. Indirect criteria he used to indicate the presence of a nesting pair were: "Nests contain eggs or young, and those visibly disturbed meant predation had probably occurred before observation." He states, "In the latter case renesting activity in the same vicinity frequently occurred, which verified the presence of a nesting pair." Using these criteria he was able to locate 361 active nests in 1956 and 364 in 1957.

In this investigation it was necessary to continue to study magpies and determine if any important variation in density occurred. It did not appear feasible to inspect all the active nests on the 6 square mile area. A perusal of Brown's (1957) data indicated very little variation in density on one half vs. the other half of the study area so it was believed that a 50 per cent census would reveal any important change. This census was made by climbing to about two thirds of the nests, but the remaining one third were not climbed to and were assumed to be active if: an adult left the nest, young could be heard, or twigs had lately been added to the nest canopy. Approximately twice in each square mile, in which there was an average of 55.5 nesting pairs (Brown, 1957), nests thought to be active were climbed to and found to be inactive. It is thought the bias injected because of this was too small to importantly effect the results of the census.

As previously mentioned, the magpie nesting census was originally planned for 3 sections (half the study area) and was carried out in this manner in 1958 (Table IV). In 1959 when the same 3 sections were censused, the gradual decrease

TABLE IV

MAGPIE NESTING DENSITY IN THE BURNT FORK VALLEY

	Section Number			
Year[1]	25	31	36	Total Number Active Nests
1956	84	42	84	210
1957	63	41	79	183
1958	43	50	80	173
1959	34	37	67	138

[1]Data for 1956 and 1957 obtained by Brown (1957).

observed in nesting pairs in 1957 and 1958 had become more acute. The remaining half of the area which consisted of 1 entire section and portions of 5 others was then also censused; The results appear in Table V. The discrepancy of 35 active nests between 1958 and 1959 in sections 25, 31, and 36 was compensated for elsewhere in the study area. This was especially true on section 33 (Table V) where the 9 active nests found in 1957 had increased to 43 by May of 1959. Four of the 5 remaining sections also exhibited increases. This shift in active nests from the northwest portion of the study area to the central and eastern sections may partly take place because of current rancher practices involving, habitat destruction, magpie trapping, and the annihilation of entire broods by burning nests.

TABLE V

MAGPIE NESTING DENSITY IN THE BURNT FORK VALLEY

	Section Number							
Year[1]	5[2]	6[2]	29[2]	30[2]	32	33[2]	Total Nests On These Sections	Total Nests On Area
1957	61	25	18	26	42	9	181	364
1959	67	28	26	18	57	43	239	377

[1]Data for 1957 obtained by Brown (1957).

[2]Not entire sections.

The total magpie nesting pairs on the area was 361 in 1956, 364 in 1957 (Brown, op. cit.), undetermined in 1958, and 377 in 1959. It can be concluded then that the population density of the magpie remained remarkably constant during the 4 year period of study.

PHEASANT NESTING STUDIES

One step in arriving at the reproductive rate and productivity of an avian species is a detailed study of its nesting activities. When combined with figures of known magpie predation, this knowledge will also yield basic information from which the predatory aspects of the magpie on pheasant eggs may be better evaluated.

<u>Banding, Tagging, And Releasing Game Farm Pheasants</u>. Game farm hens were released in the Burnt Fork Valley during the 2 years of this study (Table VI). During Phase I birds were released to investigate the feasibility of studying the predation on a released population. It was realized in making these releases that there would be a sudden increase in population density which would probably only be temporary, the pheasant numbers dropping to carrying capacity during the winter months. The data show this was the case and no permanent increase in the population occurred. Because the game farm birds were introduced in the spring there was a marked increase in the pheasant population just preceding nesting, but this was forseen and planned as an integral part of the study. This temporary increase in nesting pheasants enabled magpie predation to be simultaneously studied on nests of wild and game farm birds. Although it might be argued this introduced an artificial situation it is believed that the quantitative data obtained greatly offset any artificiality and any artificiality that did exist could be measured and evaluated.

All 598 adult female pheasants released each spring were marked with both a numbered leg band and a colored plastic neck jesse of the type developed by Craighead and Stockstad (1956). Eighty-three birds in both releases in 1958 were individually marked by the application of various color combinations of dyes upon the plastic jesses. It was found

TABLE VI

GAME FARM PHEASANT RELEASES IN THE BURNT FORK VALLEY

Year	Month and Day	Number Hens	Number Cocks	Total No. Hens Released For The Year	Total No. Cocks Released For The Year	Total Birds Released For The Year
1956	April 18	165	16	330	32	362
	June 4	165	16			
1957	April 18	150	15	300	80	380
	June 3	150	65			
1958	April 17	299	0	598	0	598
	May 29	299	0			
1959	April 29	299	0	598	0	598
	June 5	299	0			
Totals		1826	112	--	--	1938

desirable to mark more in this manner and so in 1959 all 598 hens were individually marked. J. Craighead (unpub.) has tested these plastic neck markers on penned game farm pheasants and found no loss of the jesses the first year. The jesses and legbands were attached 3 days prior to release so that the birds might become accustomed to them. Nine release points were initially established, but one was deleted when it was learned a nearby ranch dog was taking some of the newly liberated birds.

Reproductive Capacity. In order to evaluate predation it is essential to know the reproductive rate of a species and the ultimate success of nesting measured in terms of birds produced to a harvestable age. If this is known and predation during the period is accurately measured, then the predation can be evaluated in terms of its ultimate effect on the annual increment. With this in mind the reproductive success was determined for both wild and released pheasants.

Collection of Nesting Data. A well-trained female German short-haired pointer was heavily relied upon to find the pheasant nests. Each nest was visited twice a week at which time records of the nest and the condition of its contents were noted. This information was then transferred daily to a cumulative data sheet of which there was one for each nest. Ranchers interested in the study often volunteered information about new nests.

Clutch Sizes. Clutches in the Burnt Fork area are divided into wild, game farm, and unknown categories, depending on the identity of the incubating hen (Table VII). Table VII lists the total number of nests, the total number of eggs, and the average number of eggs per nest for each of these categories. Although a total of 75 nests were found in 1958 and 81 in 1959 only nests in which incubation had commenced (bona fide nests) are utilized here. In 1958, 9 wild nests were located vs. a game farm total of 25. During 1959 an identical number of

TABLE VII

PHEASANT REPRODUCTIVE RATE IN THE BURNT FORK VALLEY

	Wild Hen		Game Farm Hen		Unknown Hen		Grand Total	
	1958	1959	1958	1959	1958	1959	1958	1959
Total No. Nests	9	17	25	25	18	5	52	47
Total No. Eggs	89	175	174	162	143	38	406	375
Ave. No. Eggs/ Nest	9.9	10.3	6.9	6.5	7.9	7.6	7.8	8.0
Standard Error	9.9 ±.16	10.3 ±.09	6.9 ±.07	6.5 ±.07	7.9 ±.17	7.6 ±.48		
95 Per Cent Confidence Limits	9.5 to 10.3	10.1 to 10.5	6.7 to 7.1	6.3 to 6.7	7.5 to 8.3	6.3 to 8.9		

game farm nests were observed (25); however, almost twice as many wild nests (17) were found. In 1959, when a student assistant was present to help identify flushed hens, data which had to be placed in the unknown category were greatly reduced, i.e., 18 unknown nests in 1958 dropped to only 5 in 1959. The majority of this new element of known birds appears to have been wild individuals, for the number of wild nests nearly doubled in 1959. When both years' data are combined it may be seen that although the game farm nests outnumber those of the wild birds almost 2 to 1, the difference between the total number of eggs produced in each population is only 12 per cent of the total production. This percentage would have been 33 if the number of eggs produced was directly proportional to the number of nests in each population. The reason for this low figure (12 per cent) is, of course, the average clutch size. Comparing averages of the 2 years there is a difference of 3.4 eggs per clutch, with the wild hens producing the larger (10.1 vs. 6.7). Confidence limits of 95 per cent (Table VII) show no overlap between the average clutch sizes of wild compared to game farm birds. Thus the difference expressed by the averages appears not to be one of pure chance. The average clutch size for wild birds in this study is slightly smaller than reported by Hart et al. (1956) for the Sacramento Valley. The number of eggs there averaged 12 per clutch for the 4 years 1947-1950. Hamerstrom (1936) found the average clutch size in Iowa to be 11.6 in the years 1933, 1934, and 1935. Smaller clutch sizes for wild birds are noted in the studies of Eklund (1942) in Oregon and Salinger (1952) in Idaho where they were 10.45 and 9.8 respectively. Woodgerd (1952) observed a 10.5 average clutch in Montana for 1950. Few data for released game farm birds are available. Buss et al. (1951) in Wisconsin, working with penned game farm birds arrived at an average of 9.9 eggs per nest, a considerably higher figure than the 6.7 in this study. However, the game farm birds in the Burnt Fork had laid a clutch previous to their release. In Ohio, Seubert (1952) found a mean clutch size of 9.7 for 63 nests of game farm birds released in a 7.85 acre enclosure.

From the forgoing information it may be concluded that clutches of wild birds in the Burnt Fork area are slightly smaller than those occurring in the midwest but conform quite closely to those found in Idaho and western Montana. Game farm birds in the study area laid smaller clutches than is the case elsewhere. However, the data are not strictly comparable, because data in the literature were taken from birds either penned or restricted to a 7.85 acre enclosure and clutches laid by the birds in the Burnt Fork area were not their first of the season.

Renesting. In a wild pheasant population it is difficult to establish the validity of renesting and even more of a problem to figure the extent to which it occurs. Seubert (op. cit.) says this is because, "All nests cannot be found; the loss of hens during the breeding season can only be estimated; there may be a differential egress and ingress of breeders with or without broods; and accurate nest desertion rates are not obtained." Some investigators are apt to label clutches "renests" because of the lateness of the season and the small number of eggs (Hamerstrom, 1936). A search of the literature disclosed no observed renesting of individually marked pheasants prior to the work of Seubert. Many marked hens in Seubert's study nested twice and a few as many as 3 times. In the present study 764 individually marked hens were released in the Burnt Fork Valley. When any of these marked game farm birds had their clutches destroyed an attempt was made to locate new nests (renests). Once every 3 days for a duration of 12 days the area within a radius of 200 yards of the destroyed nest was methodically searched. Only once did this technique prove successful. On May 27, 1959 a game farm female with an individualized neck jesse was located on a clutch of 5 eggs. Two subsequent visits established that incubation was under way. On June 4th the hen abandoned the nest due to the activities of a rancher repairing a nearby fence. Two searches at 3 day intervals located no renest, however, on the third try the hen was found approximately 85 yards southeast of the original site. The renest contained 2 eggs which were destroyed 2 nights later by a skunk. No further renesting was observed. Although only this one instance of renesting was noted, observation of young chicks in mid-and late-August showed that some renesting probably occurs.

Egg Mortality Factors

Desertion. Desertion accounted for 17 per cent of the eggs in unsuccessful nests in 1958 and 8 per cent in 1959 (Table VIII). Figure 1 illustrates this abandonment by month. In both years the bulk of the desertion occurred in June followed closely by May. Desertion dwindled sharply in July and was almost nonexistent by August. These data agree with Stokes (1954) who found that abandoned nests on Pelee Island were most frequent at the beginning of the nesting season

TABLE VIII.

FATE OF BONA FIDE* PHEASANT NESTS

In the Burnt Fork Valley

	Wild Hen		Game Farm Hen		Unknown Hen	
	1958	1959	1958	1959	1958	1959
Total No. of Nests	9	17	25	25	18	5
Successful Nests						
No. of Nests	1	5	4	3	1	1
Total No. Eggs	12	55	32	24	6	11
Eggs Hatched	9	44	27	21	6	11
Fate of Unhatched Eggs						
Dead Embryo	3	10	3	3	0	0
Infertile	0	1	2	0	0	0
Unsuccessful Nests						
Total No. Nests	8	12	21	22	17	4
Total No. Eggs	77	120	142	138	137	27
Fate of Unsuccessful Nests						
Predation						
Magpie						
No. of Nests	2	1	3	3	1	0
Total No. Eggs	22	11	18	17	9	0
Skunk						
No. of Nests	1	3	10	7	6	4
Total No. eggs	11	32	63	43	44	27
Weasel						
No. of Nests	0	0	0	1	1	0
Total No. Eggs	0	0	0	5	10	0
Unknown Sm. Mammal						
No. of Nests	0	0	0	0	2	0
Total No. Eggs	0	0	0	0	19	0
Dog						
No. of Nests	0	0	1	0	0	0
Total No. Eggs	0	0	9	0	0	0
Unknown						
No. of Nests	0	1	1	0	1	0
Total No. Eggs	0	10	5	0	12	0
Other Than Predation						
Desertion						
No. of Nests	4	1	3	2	1	0
Total No. Eggs	34	11	21	13	6	0
Mowing						
No. of Nests	1	5	3	9	3	0
Total No. Eggs	10	44	26	60	14	0
Farm Practices Other Than Mowing						
No. of Nests	0	1	0	0	2	0
Total No. Eggs	0	12	0	0	23	0

*Only those nests in which incubation has commenced.

(Cont. on Next Page)

TABLE VIII.
(cont.)

	Totals 1958	1959	Grand Total
Total No. of Nests	52	47	99
Successful Nests			
No. of Nests	6	9	15
Total No. Eggs	50	90	140
Eggs Hatched	42	76	118
Fate of Unhatched Eggs			
Dead Embryo	6	13	19
Infertile	2	1	3
Unsuccessful Nests			
Total No. Nests	46	38	84
Total No. Eggs	356	285	641
Fate of Unsuccessful Nests			
Predation			
Magpie			
No. of Nests	6	4	10
Total No. Eggs	49	28	77
Skunk			
No. of Nests	17	14	31
Total No. Eggs	118	102	220
Weasel			
No. of Nests	1	1	2
Total No. Eggs	10	5	15
Unknown Small Mammal			
No. of Nests	2	0	2
Total No. Eggs	19	0	19
Dog			
No. of Nests	1	0	1
Total No. Eggs	9	0	9
Unknown			
No. of Nests	2	1	3
Total No. Eggs	17	10	27
Other Than Predation			
Desertion			
No. of Nests	8	3	11
Total No. Eggs	61	24	85
Mowing			
No. of Nests	7	14	21
Total No. Eggs	50	104	154
Farm Practices Other Than Mowing			
No. of Nests	2	1	3
Total No. Eggs	23	12	35

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TABLE VIII.
(cont.)

SUMMARY

1958 - Magpies destroyed 14 per cent of eggs in unsuccessful nests.

1959 - Magpies destroyed 10 per cent of eggs in unsuccessful nests.

1958 - Skunks destroyed 33 per cent of eggs in unsuccessful nests.

1959 - Skunks destroyed 36 per cent of eggs in unsuccessful nests.

1958 - Mowing destroyed 14 per cent of eggs in unsuccessful nests.

1959 - Mowing destroyed 36 per cent of eggs in unsuccessful nests.

1958 - All predation other than that of magpie destroyed 79 per cent of eggs lost only to predation.

1959 - All predation other than that of magpie destroyed 80 per cent of eggs lost only to predation.

and became fewer as the season advanced. Buss *et al.* (1951), studying pheasant reproduction in Wisconsin, worked with the ovulated follicles of 44 wild hens and found that individual birds had laid up to 50 eggs. As a result of this these authors are of the opinion that the high rate of desertion, common among captive hens, also applies to the hens in a wild population. In this study, 5 of the bona fide abandoned nests in which the hen's identity was known were released birds and 5 were wild. These data tend to support the conclusions of Buss *et al.* (1951) and Stokes (1954).

Infertility And Embryo Mortality. Only 3 (2 per cent) of 140 eggs in 15 successful nests were infertile (Table VIII). This fertility is high compared to the figures of various studies (Baskett, 1947; Carlson, 1942; Hamerstrom, 1936; Nelson, 1956; Randall, 1954; Stokes, 1954; and Twining *et al.* 1948) which range from 86.7 per cent (Stokes, *op. cit.*) to 96.9 per cent (Carlson, *op. cit.*) and average 92.8 per cent.

Nineteen or 13.6 per cent of the total eggs in successful nests had dead embryos (Table VIII). This percentage closely resembles the results of Hamerstrom (1936) in Iowa who found dead embryos in up to 14 per cent of the eggs examined.

Infertility and dead embryos were responsible for 16 per cent of the eggs not hatching in successful nests. This approximates the 17.2 per cent found by Hamerstrom (1936) in Iowa, the 16 per cent found by Twining *et al.* (1948) in

California, and the 12.8 per cent found by Nelson (1956) in South Dakota. On the basis of these data, hatchability (the percentage of eggs which hatch in successful nests) in the Burnt Fork is similar to that found in other studies.

Predation. Two methods were used to identify predators of pheasant nests. A series of dummy pheasant nests (Stanton, 1944) were kept under surveillance with a longspring trap placed at each site so the predator, when caught, could be directly related to the condition of the nest, its contents, and the cover in the immediate vicinity. The dummy nest studies are covered in detail in a separate section (page 45). Information from these nests plus information from Darrow, 1938; Randall, 1940; Rearden, 1951; and Stanton (op. cit.) made it possible to identify many nest predators where only indirect evidence was present.

In this study magpies and skunks were responsible for by far the greatest egg losses. Magpies accounted for 14 per cent of the eggs in the unsuccessful nests in 1958 and 10 per cent in 1959 (Table VIII). Skunks destroyed 33 per cent of the eggs in 1958 and 36 per cent in 1959, almost 3 times the amount attributed to the magpie. All predation, other than that caused by the magpie, took 79 per cent of the eggs lost only to predation in 1958 and 80 per cent in 1959. Of 46 unsuccessful nests in 1958, 29 of these or 63 per cent were the result of predation. In 1959, 38 were unsuccessful and 20 of these or 53 per cent were due to predation. Hamerstrom (1936) in Iowa, Randall (1940) in Pennsylvania, and Strode and Leedy (1948) in Ohio, report predation figures in the form of percentages of unsuccessful nests as 19 per cent, 31 per cent, and 18 per cent respectively. Predation figures for the northwestern section of the nation are submitted by Eklund (1942) and Salinger (1952). Eklund, working in the Willamette Valley of Oregon found predation to cause a loss of 15 per cent of the unsuccessful nests (total of 80 nests); Salinger's figure for southwest Idaho was 13.2 per cent (total of 38 unsuccessful nests). Egg predation in the Burnt Fork Valley is then twice as heavy as the figures quoted from the eastern half of the nation and closer to 4 times the figures quoted from Oregon and Idaho.

Looking at the predation-caused nest failures by months (Figure 1) it may be seen that the magpie exerted the heaviest pressure early in the season, becoming less and less an important factor as the summer progressed. The skunk exerted little pressure early in the season but surpassed the magpie in June, July, and August.

It is interesting to compare skunk predation on abandoned and nonabandoned nests (Table IX). It was found in all cases that when a nest was located by a skunk all eggs were destroyed. In abandoned nests the average delay between the time the nest

TABLE IX

SCENT AS A FACTOR IN SKUNK PREDATION ON PHEASANT NESTS

	Year	No. Nests	No. Eggs	Ave. No. Days Until Complete Destruction
Abandoned Nests[1]	1958	5	39	42
	1959	3	36	22
Non-Abandoned Nests[2]	1958	10	70	11
	1959	10	78	9

[1]Hen has deserted nest, scent not a strong factor.

[2]Hen on nest, scent a strong factor.

was found and the time predation took place was 42 days in 1958 and 22 days in 1959 whereas in nests where the hen continued to incubate this delay was 11 and 9 days for 1958 and 1959 respectively. It is believed that the presence of the female on the nest acted as a scent factor and was responsible for predation occurring twice as rapidly on the occupied as the abandoned nests.

Man's Activities. Mowing has long been described as the scourge of pheasant nests and the literature is replete with examples bearing this out. Trippensee (1948) summarizes studies in 4 different states and lists the percentages of nest destruction caused by mowing as: Iowa 30 per cent, Michigan 53 per cent, Ohio 54 per cent, and Pennsylvania 50 per cent. Yeager et al. (1956) state that the loss from mowing in Colorado and Utah varies from about 35 per cent to 50 per cent. Eklund (1942) in Oregon, reports a 55 per cent loss of nests from this cause. In the Burnt Fork Valley the mowing loss averaged 25 per cent for the 2 years of this study (Table VIII and Figure 1). When compared to the other studies mentioned, this figure is low. It is thought this is probably due to the fact that obtaining data on mowing was incidental to obtaining information more pertinent to the study and was therefore underestimated. Losses from mowing appear to suddenly increase the second summer but it is believed the ranchers were more cognizant of the study by then and consequently were more alert in noticing the egg mortality they caused.

Successful nests were few in the Burnt Fork as only 15 (15 per cent) of the 99 bona fide nests under observation hatched. Other studies by Stokes on Pelee Island (1956), where abandoned nests were excluded from the data, and Woodgerd (1952) in western Montana, where abandoned nests were not excluded, report successes of over 70 per cent and 61 per cent respectively. The wild hens had a 23 per cent success (6 of 26 clutches hatching) while the released pheasants were only able to hatch 7 of 50 nests for a 14 per cent success. Hens

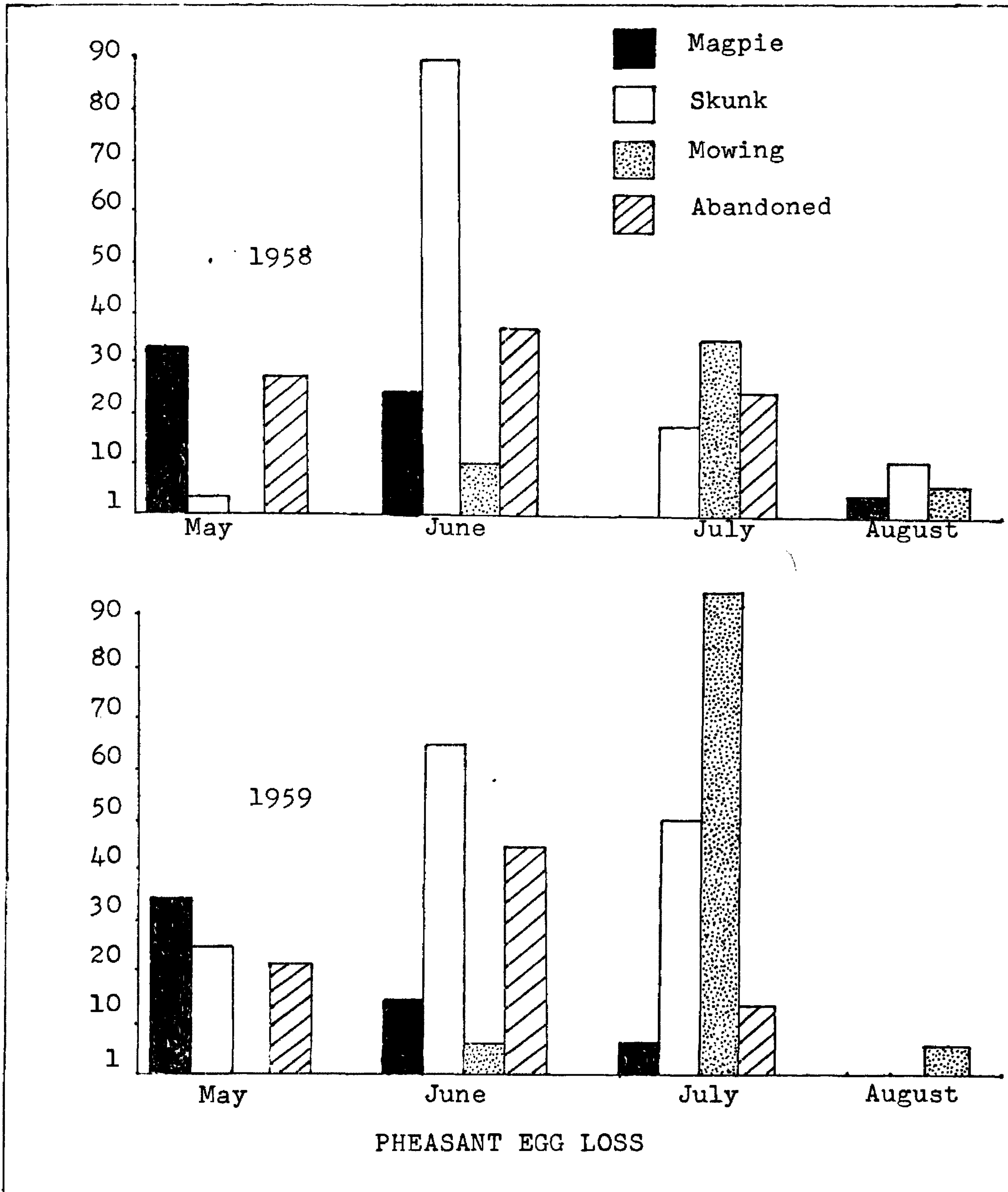

Magpie
Skunk
Mowing
Abandoned
1958
90
80
70
60
50
40
30
20
10
1
May
June
July
August
1959
90
80
70
60
50
40
30
20
10
1
May
June
July
August
PHEASANT EGG LOSS

FIGURE 1

in the unknown category hatched 2 of 23 nests for a success of 9 per cent. The data indicate nest predation and mowing were the most important factors behind this rather meager nesting success on the study area.

Productivity

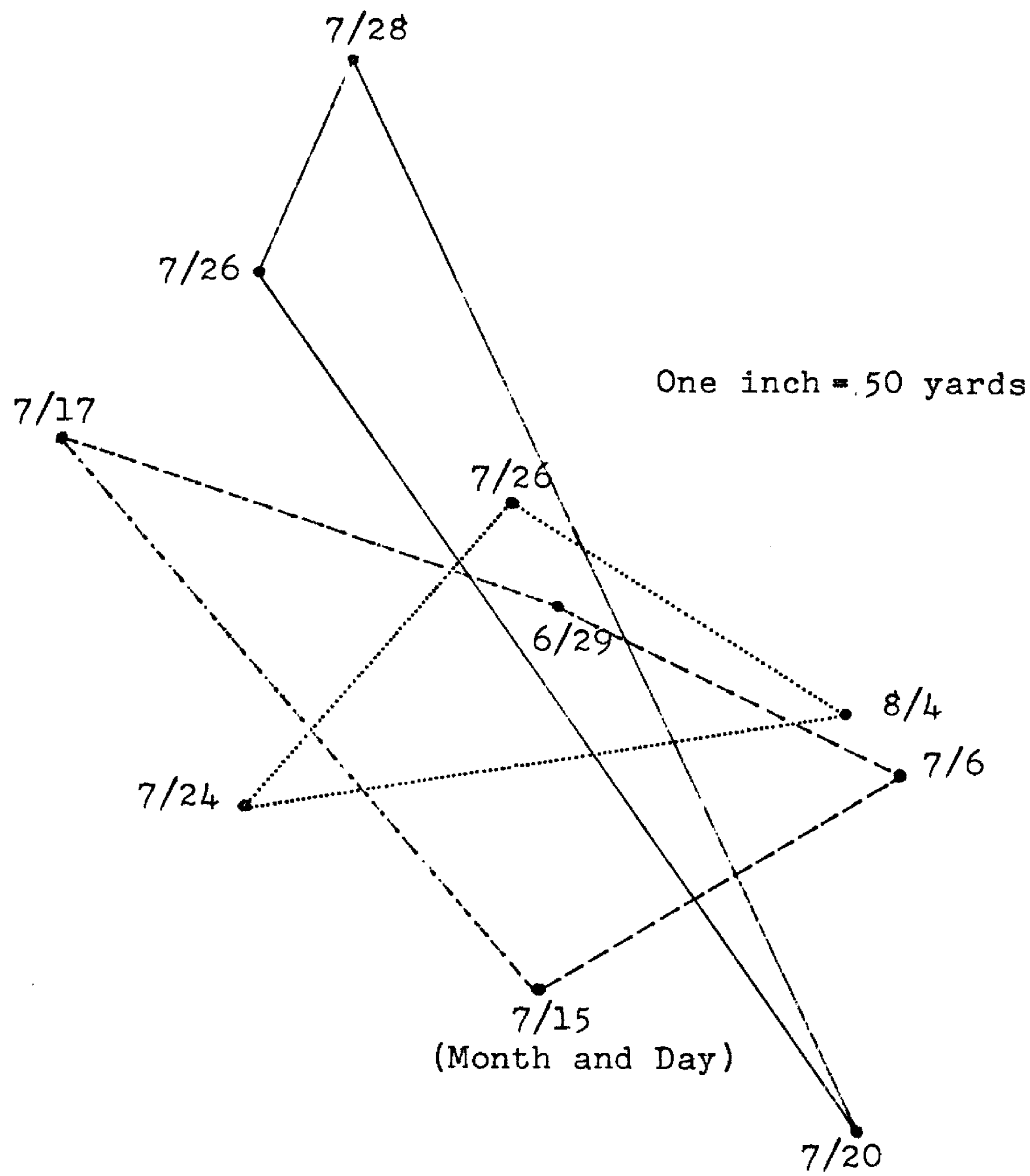
Brood Count Methods and Techniques. Brood count data were largely gathered in the early daylight hours as well as the late evening. The German short-haired pointer proved invaluable in this activity also. Broods were classified into 3 different size and age phases, a method developed by Brown (pers. com.)

Phase I - From hatching until flight status was gained.

Phase II - When the bird was able to fly until it reached the size of a Hungarian partridge.

Phase III - Larger than a Hungarian partridge but smaller than an adult pheasant.

Since 166 game farm birds were individually marked in 1958 and 598 in 1959, it was possible to follow the fate of the broods of some known hens throughout both summers. These marked birds with broods restricted their activities to limited areas (Figure 2). In some cases it could be seen a hen was wearing a neck jesse but the color combinations were not discernable. When a bird in this category was repeatedly observed within a restricted area it was assumed that this was the same bird. Although some bias may have crept in by



SIGHTINGS OF INDIVIDUALLY MARKED
HENS WITH BROODS

FIGURE 2

the use of this method, the restricted ranges utilized by hens during summer precluded any serious error.

Wild hens with broods were also observed to remain in rather confined localities. Thus it was possible to associate specific broods with specific areas and differentiate between them in counts.

Late August Census Methods And Techniques. Records were kept of all pheasants observed during the summer of 1958. However, it was found impossible to use these data to compute a total population figure for late summer of that year because these data were not sufficiently complete. It was decided that a complete and accurate pheasant census at this date was feasible and if made would yield the total number of hens as well as just those with broods in the last week of August. Accordingly, this was done during the summer of 1959. Two men, each with a dog, made the census which was a flushing-type count. Every section was systematically searched, approximately 80 man-hours being required for a complete census of the area.

Results Of Productivity Study

Brood Counts. Pheasant productivity data are presented in Tables X, XI, and XII. These data were arrived at in 2 ways: Table X represents a pheasant census of the entire area during the last week of August 1959 (see previous section); Tables XI and XII were compiled from brood counts

TABLE X

PHEASANT PRODUCTIVITY BASED ON LATE AUGUST CENSUS, 1959

	Identity Of Hen			
	Wild	Game Farm	Unknown	Totals
Total No. Broods Produced, A	61	22	9	92
Total No. Broods Present In Late Aug., B	26	11	1	38
Brood Mortality, A-B	35	11	8	54
Total No. Young In Late August	146	47	7	200
Average No. Young Per Brood In Late August Based On Hens With Broods	5.6	4.3	7.0	5.3
Total No. Hens Without Young In Late Aug.	37	57	6	100
No. Young Per Hen Based On Total Hen Population In Late August	2.3	0.7	1.0	1.5

TABLE XI

BROOD COUNTS RELATED TO IDENTITY OF HEN

	May		June		July		Aug.		Totals		Grand
	58	59	58	59	58	59	58	59	58	59	Total
Wild Hen											
No. Broods	3	3	7	10	27	17	12	31	49	61	110
No. Young	6	29	28	56	152	102	67	142	253	329	582
Aver. No. Young/Brood	2.0	9.7	4.0	5.6	5.6	6.0	5.3	4.7	5.2	5.4	5.3
Game Farm Hen											
No. Broods	0	0	0	3	10	4	12	15	22	22	44
No. Young	0	0	0	8	48	23	54	51	102	82	184
Aver. No. Young/Brood	0	0	0	2.7	4.8	5.8	4.5	3.4	4.6	3.7	4.2
Unknown Hen											
No. Broods	0	0	1	0	18	3	20	6	39	9	48
No. Young	0	0	7	0	79	15	99	28	185	43	228
Aver. No. Young/Brood	0	0	7.0	0	4.4	5.0	4.9	4.7	4.7	4.8	4.7
Total No. Broods/Month	3	3	8	13	55	24	44	52	110	92	202
Total No. Young/Month	6	29	35	64	279	140	220	221	540	454	994
Aver. No. Young/Brood	2.0	9.7	4.4	4.9	5.1	5.8	5.0	4.3	4.9	4.9	4.9

TABLE XII

BROOD COUNTS RELATED TO GROWTH OF YOUNG

	May		June		July		Aug.		Totals		Grand Total
	58	59	58	59	58	59	58	59	58	59	
Phase I											
No. Broods	2	3	3	7	3	3	1	4	9	17	26
No. Young	4	29	3	35	12	18	5	10	24	92	116
Aver. No. Young/Brood	2.0	9.7	1.0	5.0	4.0	6.0	5.0	2.5	2.7	5.4	4.5
Phase II											
No. Broods	1	0	5	6	38	15	24	20	68	41	109
No. Young	2	0	32	29	188	89	117	83	339	201	540
Aver. No. Young/Brood	2.0	0	6.4	4.8	4.9	5.9	4.9	4.2	5.0	4.9	5.0
Phase III											
No. Broods	0	0	0	0	14	6	19	28	33	34	67
No. Young	0	0	0	0	79	33	98	128	177	161	338
Aver. No. Young/Brood	0	0	0	0	5.6	5.5	5.2	4.6	5.4	4.7	5.0
Total No. Broods/Month	3	3	8	13	55	24	44	52	110	92	202
Total No. Young/Month	6	29	35	64	279	140	220	221	540	454	994
Aver. No. Young/Brood	2.0	9.7	4.4	4.9	5.1	5.8	5.0	4.3	4.9	4.9	4.9

which extended from May through August of both years. A total of 110 separate broods were tallied in the Burnt Fork in 1958 and 92 in 1959. The breakdown of the broods in 1958 was: 22 game farm, 49 wild, and 39 unknown; in 1959 it consisted of 22 game farm, 61 wild, and 9 unknown. When data on game farm brood size in August of 1958 and 1959 are combined there is an average of 4.0 young per brood. The average number of young per brood for wild hens in August, based on both years' data was 5.0. The brood count data then indicate that the average wild brood is one bird larger than the average game farm brood. It should be recalled that many hens which in 1958 would have been classified as unknown, were definitely identified in 1959. The majority of these birds proved to be wild. This increased the recognized wild population in 1959. The unknown birds produced 20 broods in August of 1958 and only 6 in August of 1959, averaging 4.8 young when the data for both years were combined.

The phase of growth of all broods (I, II, or III) was noted and appears in Table XII. In 1958 difficulty was experienced in locating all chicks in phase I broods. However, more accurate counts were obtained in May of 1959. The high count for phase I occurred in June (a total of 10 broods for the 2 years); phase II was most numerous in July (53 broods); and phase III most numerous in August (47 broods). Little could be concluded from the average monthly sizes of these phase groups except that the peak of hatch was probably in the second half of June.

Late August Census Of 1959. The late August pheasant census of 1959 (Table X) is believed to resemble more closely the true picture of broods at that time of year than Table XI which is a comparison of all broods for the whole of August. Data from Table X indicate that only 11 of the original 22 game farm broods, known to have been produced, were present in late August. These 11 broods averaged 4.3 young. This corresponds rather closely to the average game farm brood size of 4.0 determined from the August brood counts in Table XI. No comparative data on game farm broods in late August were located in the literature.

The August census disclosed a wild brood average of 5.6 young. This was derived from 26 broods, all that remained of the 61 known to have been produced. This average is slightly over half a bird per brood higher than that determined from 42 broods in the August brood counts of 1958 and 1959. Both Randall (1940), in Pennsylvania and Robertson (1958), in Illinois, found the number of chicks per wild brood in late August to be 7.0. Kozicky (1951), in Iowa, arrived at a brood size of 3.9 young per hen for the same date. Hiatt and Fisher (1947), working in central Montana, arrived at a wild brood size that compared exactly with the wild brood figures from the Burnt Fork area. They found an average size of 5.6 young per brood occurring in the interval from August 16 to August 30.

A count of all hens without young was an integral part of the 1959 August census. Of the 100 hens counted, 57 (57 per cent) were game farm individuals, 37 (37 per cent) were wild birds, and 6 (6 per cent) were in the unknown category. With this information it was then possible to compute the number of young per hen based on the total female population in late August (Table X). This was 2.3 young per hen for the wild population, 0.7 young per hen for the game farm contingent, and 1.0 for the unknown hens. For all hens on the area (irrespective of identity) this figure was 1.5 young per female. Stokes (1952) gives a comparable ratio of 1.65 young per hen in the form of an average for the 4 years 1947 through 1950. Kimball (1948), working in the Dakotas, found the young per hen ratio to be 1.57. The Burnt Fork young per hen ratio of 1.5 then agrees closely with both of these studies.

Summary. An average of 4.0 young per game farm hen and 5.0 per wild hen was derived from the August brood counts of 1958 and 1959. The August census of 1959 (believed to be the more accurate of the 2 methods) indicated a 4.3 average brood size for the game farm hens and a 5.6 average for the wild hens. This census made it possible to determine the average number of young per brood in late August based on hens with broods. This was 5.3. It also made it possible to determine the number of young per hen based on total female population in late August. This was 1.5.

From the foregoing data it may be concluded that pheasant brood sizes in the study area are probably normal for Montana and are comparable with data presented in the literature from other areas. This would appear to indicate that environmental resistance factors were not abnormal.

DETERMINING PHEASANT MORTALITY

Direct Method. Because of the nature of this study the majority of the investigator's time was spent actually in the field covering the area repeatedly. This afforded a chance to find many adult pheasant kills. When a predator was involved in a kill, teeth marks on bones, tracks in the snow, and the location of the kill were sometimes sufficient to label the predator, but many had to be listed as unknown.

In March and April of both years the study area was systematically searched for great horned owl (*Bubo virginianus*) nests (Table XIII). Trees bearing nest structures not clearly discernible from the ground were climbed for a close inspection. Once the nesting sites were located, 2 in 1958 and 3 in 1959, and the young owls had hatched, visits were made to each nest 2 to 3 times weekly and pheasant kills as prey items were noted. Just prior to the time the young were fledged sufficiently to leave the nest they were tethered near the base of the nest tree for approximately 2 weeks, using the techniques described by Craighead and Craighead (1956). The adults continued to feed the young and supplemental data were accrued 2 weeks past the date the young would ordinarily have left the nest. In 1958 two young red-tailed hawks (*Buteo jamaicensis*) were also treated in the above manner.

TABLE XIII

A HISTORY OF THE GREAT HORNED OWL NESTS IN THE BURNT FORK VALLEY, 1958 AND 1959

	1958		1959		
Nest No.	1	2	1	2	3
Date Located	March 2	March 27	March 8	April 9	April 20
Date Hatched	About April 6	April 14	April 1	Early April	April 30
No. young	2	2[1]	2	2[1]	2
Date Tethered	May 10	May 10	May 14	May 14	June 9
Date Released	May 23	May 28[2]	May 30	May 30	June 30
Pheasants Occuring As Prey Items:					
Hens:					
Game Farm	16			33	
Wild	1			2	
Unknown	2			2	
Cocks:	2			1	
Unknown Sex	0			1	
Totals	21			39	
Grand Total		60			

[1]Originally three but one was crowded out of nest at an early age.

[2]One escaped and one died of unknown cause.

Indirect Method. The adult mortality which occurred from early spring until late August was determined indirectly by censuses (Craighead and Craighead, 1956), the difference between the spring and fall counts representing the mortality. This method could not be applied for measuring mortality of game farm birds because there was no ingress to compensate for the egress which was known to be taking place.

Juvenile mortality was determined in the same way by comparing the total number of broods recorded to those remaining in August (Table X). Because insufficient data were collected on phase I broods early in the season it was not possible to accurately figure the reduction of young per brood by late August.

Causes of Mortality

Adult. Two hundred and sixty-three instances of adult mortality were observed during the 2 years of this study. Of these 263 pheasants, 44 (16 per cent) were known to have been wild birds, 26 (59 per cent) being hens and 18 (41 per cent) being cocks. Game farm hens numbered 173 (66 per cent) and the remaining 46 (18 per cent) were not able to be definitely identified (Table XIV).

Mortality can best be presented by showing those birds lost to predation and those lost to other causes. Predation extracted 143 birds (54 per cent of the mortality) from the population. The remaining 120 birds (46 per cent of the mortality) were accounted for by mowing, road kills, illegal

TABLE XIV

ADULT PHEASANT MORTALITY DATA[1]

	Wild				Game Farm Hens		Unknown Whether Wild or Game Farm Hens		Unknown Sex and Whether Wild Or Game Farm		Totals		Grand Total
	Hens		Cocks										
	58	59	58	59	58	59	58	59	58	59	58	59	
Great-Horned Owl	1	2	2	1	16	33	2	2	0	1	21	39	60
Red-Tailed Hawk	0	0	0	0	1	0	0	0	3[2]	0	4	0	4
Raptor, Species Unknown	0	1	1	2	3	1	1	1	0	0	5	5	10
Skunk	0	0	0	0	1	2	0	0	0	0	1	2	3
Badger	0	0	0	0	1	0	0	0	0	0	1	0	1
House Cat	0	0	1	1	4	12	14	1	0	0	19	14	33
Dog	1	1	0	0	14	15	1	0	0	0	15	17	32
Car	1	1	0	0	6	4	0	2	0	0	7	7	14
Mowing	4	3	1	1	21	11	7	0	0	0	33	15	48
Shot	1	0	?[3]	?	1	0	0	0	0	0	2	0	2
Unknown	5	5	3	5	11	16	2	6	1	2	22	34	56
Totals	13	13	8	10	79	94	27	12	4	3	130	133	263

[1]Data covers from Jan. 1, 1958 through August 31, 1959.
[2]This represents the only juvenile mortality in this table.
[3]No attempt was made to determine the kill during the hunting season.

shooting of hens, and unknown causes. No attempt was made to measure the hunting season mortality.

Great horned owls were responsible for more adult pheasant mortality than any other one factor, predatory or otherwise. Of the 143 cases of predation noted during the 2 years the great horned owls accounted for 60 or 42 per cent. Forty-nine (82 per cent) of these 60 kills were released pheasants, 6 (10 per cent) were wild birds and 5 (8 per cent) were not able to be classified as either game farm or wild. It is realized that if the game farm population had not been introduced during this study the owls' diet would have emphasized other prey items rather than the pheasant. Studies encompassing 2 years in Michigan, in which the predation was measured in a similar way, and in a situation without introduced pheasants, substantiated this by revealing that of 260 spring food items obtained at 5 great horned owl nests, only 41 or 16 per cent were pheasants (Craighead and Craighead, 1956).

Dogs and house cats levied nearly identical total kill figures for the 2 years. The dogs took 32 birds and the cats 33 for 22 per cent and 23 per cent of the total predation, respectively. Other predators took 18 pheasants or 13 per cent of the 143 predatory kills.

Among other factors accounting for mortality were mowing, road kills, and the shooting of hens, with 48 (40 per cent), 14 (12 per cent), and 2 (1 per cent) respectively of the 120 birds which were killed by causes other than predation.

Those that were lumped together under unknown causes took 56 (47 per cent) of these 120 pheasants.

Pheasant mortality caused by predation is higher than that reported in other studies. However, almost 90 per cent of the predation and 70 per cent of the mortality other than predation, of known pheasants were game farm birds. This was to be expected as predation on such introduced populations is normally high (Buss, 1946).

Juvenile Mortality. In the Burnt Fork in 1959, 41 per cent of the wild hens had broods and 16 per cent of the game farm hens had broods. Kimball *et al*. (1956) state that in South Dakota in 1950 of 156 hens counted in the second half of August, 84 per cent had broods. During this same period in Nebraska in 1948, 60 per cent of the hens had broods (Kimball *et al*., *op*. *cit*.). Buss (1946), in Wisconsin, accounted for 11 of 224 released hens and found 5 (45 per cent) had broods. The per cent of hens with broods then is low in the Burnt Fork area.

This juvenile mortality acts on the population by extirpating entire broods (Table X) as well as individual birds (Tables XI and XII). Isolated instances of house cat and red-tailed hawk predation on juvenile pheasants were noted but no quantitative data were collected. These predators were observed to take only one young pheasant from a brood at a time. Pheasant chicks in the first week of life may be small enough to suffer some mortality from magpies. However, no instances of such predation were observed in the course of 2 springs and summers during which the investigator spent full time in the field. For this reason and because of the short period a brood is vulnerable it is felt the magpie was responsible for little, if any, juvenile mortality. Only once did the investigator witness the destruction of an entire brood. This was on May 28, 1959 when at daylight an unusually cold rain for that time of the year changed to wet, heavy snow in the Burnt Fork Valley. The snow continued to fall until 0930 M.S.T. at which time 3 inches had accumulated and remained, flattening cover and bending trees, until slightly after noon. One of the wild clutches under observation hatched the night previous to the storm and when for some unexplained reason the hen left the vicinity of the nest the brood died from exposure. Although other such instances may have taken place this was the only one observed. During the afternoon of the 28th and the morning of the 29th the contents of 10 known active magpie and 3 known active crow nests were inspected for reduction in the number of young as a result of the storm, but none was noted. Ryser and Morrison (1954), under laboratory conditions, found that a single chilling of a 2 to 3 day old pheasant chick usually was not in itself fatal, however, when repeatedly chilled by 20 minute exposures at 20°C, the development of cold resistance was impaired, and they experienced a high rate of mortality. Snow or cold rain causes mortality to chicks by food reduction in addition to chilling as 87.3 per cent of the food of one-week-old chicks consists of insects (Eklund, 1942). Mowing may be another answer for the disappearance of entire broods but no quantitative data were collected to substantiate this.

It was believed an accurate picture of juvenile mortality could be obtained by recording the number of broods that survived to late August. Brood counts, coupled with the August census of 1959, revealed that over half the wild broods (35, or 57 per cent) and just half the game farm broods (11, or 50 per cent) were eliminated in the Burnt Fork area prior to the end of August 1959. Although these data can not be directly compared with other studies it is evident that the juvenile mortality was very high.

From these data it is obvious that the released adult pheasants suffered a mortality rate many times that of the adult wild population but the total brood loss was similar in game farm and wild birds. It is significant to note that this juvenile mortality was due to causes other than the magpie.

PREDATION ON DUMMY NESTS

Methods And Techniques. Dummy nests (Stanton, 1944) were placed in the field twice each year. The purpose of this was to gather data that would supplement information gained from the wild and game farm nests. These dummy nests were inspected more frequently than the actual pheasant nests and because of this more detailed information was gained. It was recognized that placing dummy nests might cause a concentration of magpies and perhaps other predators but the possibility of this occurring would be minimized in the case of the magpies because of their restricted ranges during nesting (Brown, 1957). In order to determine specifically the predators involved it was recognized it would be necessary to inflict some mortality by trapping in order to identify them. Thus the dummy nests were confined to one locality so that any mortality would be restricted and data there could then be compared to the rest of the study area to determine any bias. The section where the nests were placed was selected particularly for its contrasting high and low magpie populations, occurring one-half mile apart. Fifteen dummy nests, with 10 eggs apiece, secured from the State Game Farm at Warm Springs, were placed in a grid of 3 rows of 5 nests at 15 yard intervals (Figure 3). This close grid arrangement was placed both in the area of high magpie population and in the area of low magpie population. In

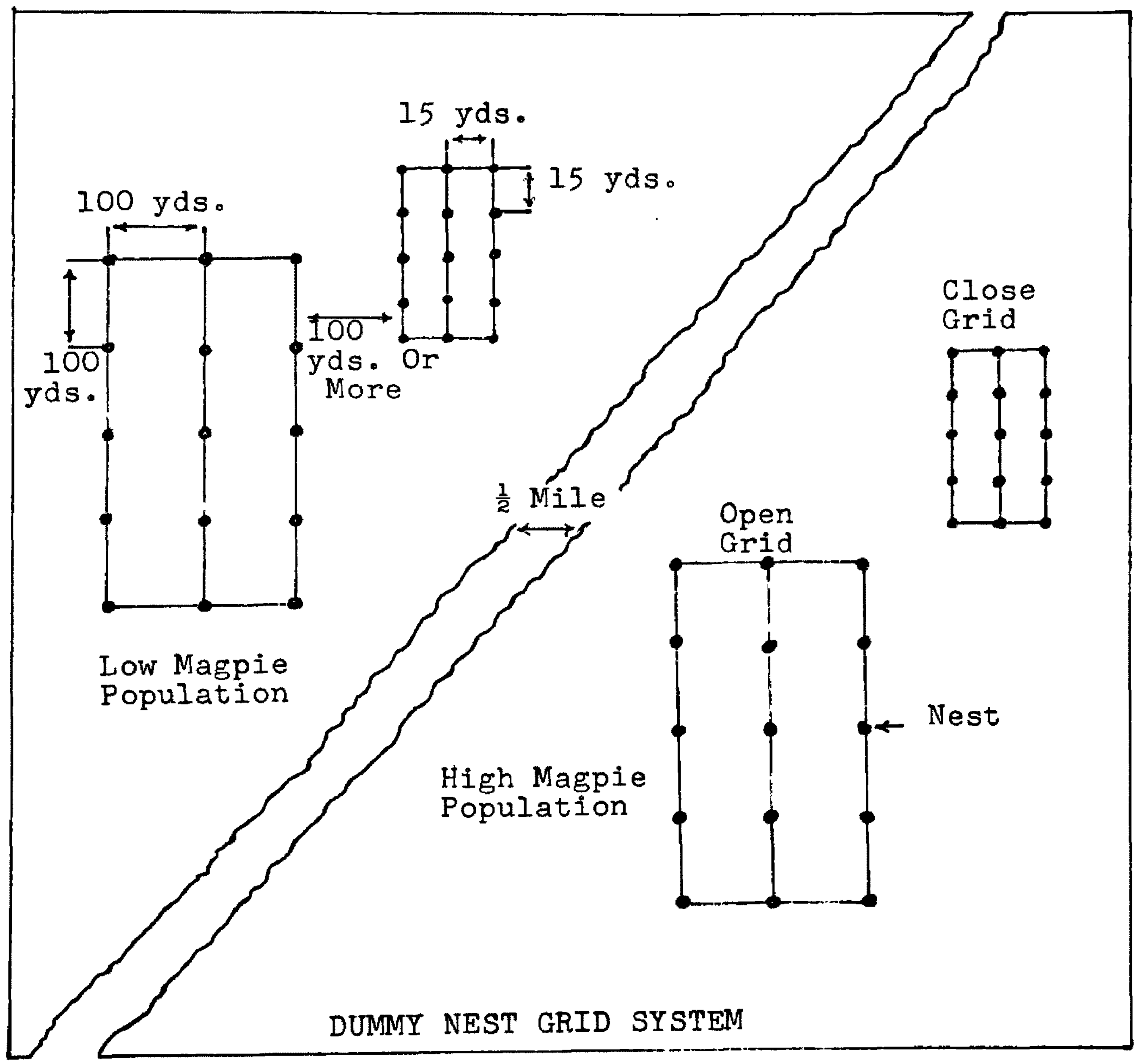

15 yds.
15 yds.
100 yds.
100 yds.
100 yds. Or More
Close Grid
½ Mile
Open Grid
Low Magpie Population
Nest
High Magpie Population
DUMMY NEST GRID SYSTEM

FIGURE 3

and are comparable with data presented in the literature from other areas. This would appear to indicate that environmental resistance factors were not abnormal.

DETERMINING PHEASANT MORTALITY

Direct Method. Because of the nature of this study the majority of the investigator's time was spent actually in the field covering the area repeatedly. This afforded a chance to find many adult pheasant kills. When a predator was involved in a kill, teeth marks on bones, tracks in the snow, and the location of the kill were sometimes sufficient to label the predator, but many had to be listed as unknown.

In March and April of both years the study area was systematically searched for great horned owl (*Bubo virginianus*) nests (Table XIII). Trees bearing nest structures not clearly discernible from the ground were climbed for a close inspection. Once the nesting sites were located, 2 in 1958 and 3 in 1959, and the young owls had hatched, visits were made to each nest 2 to 3 times weekly and pheasant kills as prey items were noted. Just prior to the time the young were fledged sufficiently to leave the nest they were tethered near the base of the nest tree for approximately 2 weeks, using the techniques described by Craighead and Craighead (1956). The adults continued to feed the young and supplemental data were accrued 2 weeks past the date the young would ordinarily have left the nest. In 1958 two young red-tailed hawks (*Buteo jamaicensis*) were also treated in the above manner.

TABLE XV (Part 1)

PREDATION ON DUMMY NESTS RELATED TO COVER

Open Grid
May

High And Low Magpie Populations

Cover	Year	Total Nests L.*	M.*	H.*	Predation Attempts: Magpie L.	M.	H.	Skunk L.	M.	H.	Other Predation L.	M.	H.	Undisturbed Nests L.	M.	H.
Alfalfa	58	5	4		1	2			1			1		4	1	
	59	1	2	1	1	2									1	1
Wild Hay	58		1												1	
	59		1	1			1								1	
Fence Line	58	1	2			2								1		
	59	3			3											
Field Border	58	2	2	1	2	1	1						1		1	
	59	6	4	1	4	5		1						2		1
Pasture	58		3	1		1	1								2	
	59	4			3			1			1					
Meadow	58		2									1			1	
	59															
Riparian	58	1	1	1	1										1	1
	59	1	1		1										1	
Brush	58	1	1	1		1		1			1					1
	59	1	1											1	1	
Totals	58	10	16	4	4	7	2	1	1	0	1	2	1	5	7	2
	59	17	10	3	14	7	1	2	0	0	1	1	0	3	4	2
Grand Total		27	26	7	18	14	3	3	1	0	2	3	1	8	11	4

*Light, medium, and heavy.

TABLE XV (Part 2)

PREDATION ON DUMMY NESTS RELATED TO COVER.

Open Grid
June

High And Low Magpie Populations

		Total Nests			Predation Attempts: Magpie			Skunk			Other Predation			Undisturbed Nests		
Cover	Year	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.
Alfalfa	58	1	5		1				1						4	
	59	1	2											1	2	
Wild Hay	58	1	1											1	1	
	59	2		1	1					1				1		
Fence Line	58	3	1	1							1			2	1	1
	59	1	3						1					1	2	
Field Border	58	1	3	2		1							1	1	2	1
	59	1	5	1	1							1			4	1
Pasture	58	1	3	1		1	1	1				2				
	59	2	1					1	1					1		
Meadow	58	1												1		
	59	1	1								1				1	
Riparian	58	1	1		1										1	
	59	1	1		1	1										
Brush	58	2	1											2	1	
	59		6			3									4	
Totals	58	11	15	4	2	2	1	1	1	0	1	2	1	7	10	2
	59	9	19	2	3	4	0	1	2	1	1	1	0	4	13	1
Grand Total		20	34	6	5	6	1	2	3	1	2	3	1	11	23	3

TABLE XVI (PART 1)

PREDATION ON DUMMY NESTS RELATED TO COVER

Close Grid
May

High And Low Magpie Populations

		Predation Attempts														
		Total Nests			Magpie			Skunk			Other Predation			Undisturbed Nests		
Cover	Year	L.	M.	H.*	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.
Alfalfa	58															
	59															
Wild Hay	58		2			2										
	59		2			2										
Fence Line	58	4	2		6	2					1			1	1	
	59	5	1		4									1	1	
Field Border	58		1												1	
	59	1	1	1	1	1	1					1				
Pasture	58	3	4		4	4										
	59															
Meadow	58		1			1										
	59	3	1		1				1					2		
Riparian	58		2			1									1	
	59	2	3		1									1	3	
Brush	58	8	1	2	7	1		1			2			2		1
	59	3	6	1	3	2			2						2	1
Totals	58	15	13	2	17	11	0	1	0	0	3	0	0	3	3	1
	59	14	14	2	10	5	1	0	3	0	0	1	0	4	6	1
Grand Total		29	27	4	27	16	1	1	3	0	3	1	0	7	9	2

*Light, medium, and heavy.

TABLE XVI (PART 2)

PREDATION ON DUMMY NESTS RELATED TO COVER

Close Grid
May

High And Low Magpie Populations

		Total Nests			Predation Attempts: Magpie			Predation Attempts: Skunk			Predation Attempts: Other Predation			Undisturbed Nests		
Cover	Year	L.	M.	H.*	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.
Alfalfa	58															
	59															
Wild Hay	58															
	59															
Fence Line	58	1	2			1								1	1	
	59	1	3	1		2	1							1	1	2
Field Border	58	4	2		4	2										
	59	1	4		1	2			2							
Pasture	58		2	1		2										1
	59		2			1									1	
Meadow	58	1	1		1	1										
	59	2	2		2	1								1	1	
Riparian	58	1		2			1							1		1
	59	3	2		3	1		1				1			1	
Brush	58	4	7	2	1	5	3		1		1			1	1	
	59	3	6		4	6										
Totals	58	11	14	5	6	11	4	0	1	0	1	0	0	3	2	2
	59	10	19	1	10	13	1	1	2	0	0	1	0	2	4	2
Grand Total		21	33	6	16	24	5	1	3	0	1	1	0	5	6	4

TABLE XVII

Predation on Dummy Nests

Predator	High Magpie Population 58	High Magpie Population 59	Low Magpie Population 58	Low Magpie Population 59
Close Grid May				
Magpie	5	1	3	1
Probable Magpie[1]	11	13	10	0
Skunk	1	0	0	3
Crow	0	0	0	0
Pine Squirrel	0	0	2	0
House Cat	0	0	1	0
Unknown	0	1	1	0
Undisturbed	3	1	3	11
Open Grid May				
Magpie	4	5	2	4
Probable Magpie	3	5	3	9
Skunk	2	2	0	0
Crow	0	0	1	1
Unknown	0	0	2	1
Undisturbed	7	5	7	4
Close Grid June				
Magpie	4	4	3	0
Probable Magpie	7	7	8	12
Skunk	1	2	0	1
Crow	0	0	0	0
Unknown	1	0	1	0
Undisturbed	2	3	5	5
Open Grid June				
Magpie	1	0	2	1
Probable Magpie	2	3	1	2
Skunk	1	2	1	2
Crow	0	0	0	1
Unknown	2	0	1	2
Undisturbed	9	10	10	8

[1] All eggs gone without a sign of shells in the vicinity, nest cover and lining not at all or only slightly disturbed and trap not sprung.

per cent, skunks accounted for 18 or 10.5 per cent, and all other predators, when lumped together, made 18 or 10.5 per cent of the attempts (Table XVIII).

The data collected from the various grids and presented in Table XVIII indicate that magpie predation was not strictly proportionate to the numbers of nesting magpies in the area even though the area chosen as one of high magpie density had approximately 10 times the population as did the area singled out for its low magpie concentration. Of the 136 instances of magpie predation on dummy nests 75 (55 per cent) were in the area of high magpie concentration and 61 (45 per cent) were in the area of low magpie concentration. This may mean, that due to competition for food, most magpies in an area of high density will tend to disperse and carry on their foraging at a considerable distance from the nest sites. Brown (1957) determined the range of nesting magpies to be about one half mile in diameter. Magpies in the area of high concentration were observed to fly away from, rather than towards the low magpie population because foraging grounds were more numerous in that direction. The results may also mean magpies can locate pheasant nests with the hen absent with such ease that the number of magpies present has no direct relation to the number of nests located.

Data from the open grids (the more natural condition) in Tables XV and XVIII suggest that magpie predation, both in the areas of low and high populations, was most intense during

TABLE XVIII

MAGPIE AND SKUNK PREDATION ON DUMMY NESTS

Open Grid
May

	Magpie[1]	Skunk	Total Predation Attempts	Undisturbed Nests
High Magpie Population				
1958	7	2	9	7
1959	10	2	12	5
Total	17	4	21	12
Per Cent Of Total Predation Attempts	81	19		
Low Magpie Population				
1958	5	0	8	7
1959	13	0	16	4
Total	18	0	24	11
Per Cent Of Total Predation Attempts	75	0		

Open Grid
June

	Magpie	Skunk	Total Predation Attempts	Undisturbed Nests
High Magpie Population				
1958	3	1	6	9
1959	3	2	5	10
Total	6	3	11	19
Per Cent Of Total Predation Attempts	55	27		
Low Magpie Population				
1958	3	1	5	10
1959	3	2	8	8
Total	6	3	13	18
Per Cent Of Total Predation Attempts	46	23		

TABLE XVIII (CONTINUED)

MAGPIE AND SKUNK PREDATION ON DUMMY NESTS

	Magpie	Skunk	Total Predation Attempts	Undisturbed Nests
	Close Grid May			
High Magpie Population				
1958[1]	16	1	17	3
1959	14	0	14	1
Total	30	1	31	4
Per Cent Of Total Predation Attempts	97	3		
Low Magpie Population				
1958[1]	13	0	17	3
1959	1	3	4	11
Total	14	3	21	14
Per Cent Of Total Predation Attempts	67	14		
	Close Grid June			
High Magpie Population				
1958[1]	11	1	13	2
1959	11	2	13	3
Total	22	3	26	5
Per Cent Of Total Predation Attempts	85	12		
Low Magpie Population				
1958[1]	11	0	12	5
1959	12	1	13	5
Total	23	1	25	10
Per Cent Of Total Predation Attempts	92	4		

[1]Includes actual and probable magpie predation.

May and showed a marked decrease between May and June of both years. Table XIX is a summation of data from these tables and shows that there was great variation in magpie predation from May to June. Of the magpie predation recorded on the dummy nests 75 per cent occurred during May and 25 per cent occurred during June. Also there was a larger number of undisturbed nests recorded in June than in May; Table XIX shows a difference of 14. The sparseness of the vegetation is believed to have accounted for heavy magpie predation in early spring and the growth of vegetation is believed to have accounted for the decrease of predation as the season progressed. This is directly related to the fact that the magpie locates nests and eggs by sight alone. Craighead and Craighead (1956) report similar findings for raptors which like the magpie are dependent upon sight alone for locating prey. They state, "With the emergence of new ground cover in early May, meadow mice, the staple food, became less vulnerable to all raptors. As the vegetation grew during spring and early summer, all prey species enjoyed greater protection. . ." They found adult ring-necked pheasants to be most vulnerable to the horned owl and Cooper's hawk (<u>Accipiter cooperii</u>) in early spring when cover was sparse and conversely greater security for both adults and juveniles as cover increased with the advance of the season. Conversely the reduction of cover over large land areas through haying and harvesting operations substantially in-

TABLE XIX

A COMPARISON OF MAGPIE AND SKUNK PREDATION ON DUMMY NESTS[1]

	Total Predation Attempts[2]	Total No. Undisturbed Nests	Per Cent Of Total Magpie Predation	Per Cent Of Total skunk Predation
May[3]	45	23	75	40
June[3]	24	37	25	60

[1]Includes data from 120 open-grid dummy nests taken from Table XVIII.

[2]One nest may have more than one predation attempt.

[3]May and June of 1958 and 1959.

creased the vulnerability.

Predation attempts were naturally more numerous in the close grids as only 15 yards separated the nests. When placed in the high magpie population the results followed much the same pattern as mentioned for the open grid. Conflicting results were obtained, however, when the close grid was put in the area of low magpie concentration in June of 1959, that is, the magpie predation increased from May to June (Table XVIII). A decrease in the skunk population (discussed later) may have been responsible for this.

The magpie appeared adept at locating dummy nests in all cover types (Tables XV and XVI) as no one type proved invulnerable.

The magpies obviously outranked the skunks, which find nests by scent, in total numbers of predation attempts, however, when skunk predation is treated separately it may be noticed that it increased (conversely to that of the magpies) between May and June (Table XIX); this despite the fact that all adult skunks caught in traps were shot. The magpie density was much higher in the valley than the skunk density and the relatively small magpie mortality which occurred by trapping at the dummy nests did not noticeably effect the population density. The adult skunk population, however, being much smaller than the magpie population and lacking the mobility of the magpie, was materially reduced from the induced mortality between May and June in the area of dummy nests. This was probably the cause of the decrease in skunk predation which took place when a second close grid was placed in the area of low magpie concentration in June of 1959 (Table XVIII). Even though skunk predation generally increased by June it was not of sufficient intensity to compensate for the drop in magpie predation because the total number of undisturbed nests increased during the same period. Of the various sorts of vegetation in which the dummy nests were placed, only in riparian cover were the skunks unsucessful (Tables XV and XVI); there they located only 1 of 24 nests. This is not unusual as skunks on the study area tended to forage along fence lines and in open fields rather than in the dense riparian cover.

The intensity of both the magpie and the skunk predation on the dummy nests during May and June was directly proportional to the intensity occurring on the wild and game farm nests during this same period. Magpie predation was heaviest in May and decreased by June while nest predation by skunks was low in May and increased by June.

Predators, other than magpies or skunks, made a total of 18 predation attempts on dummy nests. This represented only 10.5 per cent of the entire 172 attempts recorded for the 2 years. A comparable figure of 16 per cent was obtained from the nesting studies of the wild, game farm, and unknown birds (Table VIII). Three of the 18 attempts on dummy nests were by crows, 2 by pine squirrels, 1 by a house cat, and 12 had to be labeled as unknown. Thus it seems that predators, other than the magpies and skunks cause less than 20 per cent of the nest predation in the Burnt Fork area.

It was realized that dummy nests probably had a tendency to emphasize magpie predation over other types, particularly that of the skunk. Dummy nests were far more vulnerable to the magpie than true pheasant nests because the eggs were not covered by an incubating hen and they then were not only more easily spotted but also there was a lack of physical protection by the hen involved. Because the skunk relies mainly on scent, the absence of an incubating hen then must have acted as a deterant to predation (Table IX), thus it is not surprising that there was considerable difference in the amount of clutch destruction between the two.

Dummy nests resembled abandoned and dump nests more than they did bona fide pheasant nests. However, it was not feasible to compare the results obtained from the dummy nests with those of the abandoned or dump nests because of the small sample of the latter two types.

Summary Of Dummy Nest Studies. Similar amounts of magpie predation were observed on dummy nests regardless of whether they were placed in high or low magpie concentrations. Magpie predation was greatest during May and decreased markedly between May and June as the vegetation became more luxuriant. Skunk predation was least early in the season but increased as the season advanced. It is thought that the senses used by magpies and skunks in detecting the dummy nests (magpies by sight, skunks mainly by scent) were partially responsible for the difference in the amount of predation between the two. Information gathered at the dummy nests assisted in identifying the predators at the wild and game farm pheasant nests. The dummy nest study was also valuable because it showed that the difference of intensity of predation, between May and June, strongly supported the findings from the study of the wild and game farm nests (Figure 1), even if the amount of magpie and skunk predation was not the same as that occurring on the true nests.

THE MAGPIE AS A PREDATOR

Population Density. The Burnt Fork area was picked for this study particularly because of its high magpie numbers. After 2 years of intensive study, Brown (1957) determined the average density of this population to be 55.5 nesting pairs per square mile. Comparative data are lacking in the literature.

Reproductive Capacity. Dice (1917), in Washington, found the average clutch size from 13 magpie nests to be 6.85. Working with 12 nests in Nevada, Lindsdale (1937) arrived at about 1 egg less per nest or 5.7. Hartkorn (1949) studied 22 nests 30 miles north of the Burnt Fork Valley and derived an average clutch size of 7.2. However, these were comprised only of nests in which the eggs hatched. In the Burnt Fork, Brown arrived at an average clutch size of 6.41 from 229 nests in 1956 and 6.59 from 274 nests in 1957. Brown found that one clutch of eggs per nesting season was normal for the magpie. "During both years of the investigation the per cent of the eggs laid that hatched was 58.2, the per cent of young fledging from eggs laid was 51.3, and the per cent of young fledging from eggs hatching was 88.1" (Brown, *op. cit.*). In the study area the magpie then had a potential annual rate of increase of 330 per cent which was attained in the form of fledged young. However, Brown (*op. cit.*) found that when the next nesting season was reached the population had been reduced to the same level as the previous year. Thus the potentially high reproductive rate of the magpie was attained only temporarily and the numbers did not increase cumulatively to the point where predatory pressure would have been excessive.

Ranges And Territories. By making numerous observations, Brown (op. cit.) determined the range of nesting magpies to include about one-half a square mile. This range was in effect from the time laying commenced until approximately 1 week past fledging. Data gathered on density distribution of the pheasant in the Burnt Fork shows that every pheasant nest located in this study was potentially vulnerable to 1 or several pairs of magpies. During the post-nesting season the same author commonly witnessed magpie flights of one and one-half to 3 miles in extent.

Neither Hartkorn (1949) nor Lindsdale (1937) present evidence of territorialism in the magpie. Brown (op. cit.), however, worked with marked birds and was able to establish the occurence of territorial behavior. He detected two types: "primarily the defence of the immediate area surrounding the nest and secondarily the defense of a feeding area surrounding the nest." The greatest diameters of 4 feeding territory boundaries varied between 360 and 600 feet.

General Feeding Habits. Lindsdale (op. cit.) lists some of the more common food items of the magpie as: weevils, ground beetles, caterpillars, bees, ants, grasshoppers, carrion, small mammals, grain, wild fruit, and rubbish. He describes it as mainly an insect feeder.

Some people on the study area were of the belief that the magpie often preyed on young pheasants in the preflight stage, but no instances of this were observed. One rancher complained that as soon as his rabbits gave birth to young the magpies made off with these young. He never witnessed the act but surmised that magpies were the culprits because they were in the vicinity.

Magpies are not deterred in their feeding by thick vegetation. They were commonly seen searching for food in dense coverts as well as in open, short-cropped pastures. It appears they have little fear of feeding in cover which a crow would not ordinarily utilize.

An experiment of rather limited scope and duration was run near an isolated magpie nest from May 19 to May 23, 1958. A dummy pheasant nest, containing 5 eggs, was placed in light cover 30 feet from a magpie nest and the eggs replaced each day if they were pilfered. The eggs were inconspicuously marked and when the shells were located they could be readily identified. For 5 consecutive days the nest was emptied of 5 eggs, the shells being left from 3 to 60 feet from the dummy nest. The habit of the magpie of revisiting the nest until all eggs were taken was frequently observed in this study. From these observations it may be concluded that once a magpie locates a pheasant nest it will normally return until all the eggs are destroyed.

Juvenile as well as adult magpies were predators on the dummy nests for in one instance 2 young magpies were caught in the same trap at the same time. The young birds would only fly 5 to 20 feet away with the eggs before alighting and eating the contents.

The magpie, as previously mentioned, locates its food by sight. Thus, in May and early June pheasant nests with little cover and no hen present were particularly vulnerable to magpie predation (Table XX). Many pheasant nests early in the season are comprised of single dropped eggs, which at times may not be in prepared nest structures, and dump nests (Buss et al., 1951; Stokes, 1956). It is not surprising then to learn that magpie predation of pheasant eggs is highest at that time and decreases steadily as the vegetation masks the nests and insects become more easily obtainable as a food source.

EVALUATION OF MAGPIE PREDATION ON PHEASANTS

In the Burnt Fork Valley the magpie is a potentially serious predator of pheasant eggs. This study has shown that its density is high, and its range during the nesting season is extensive enough so that practically the entire area

TABLE XX

MAGPIE PREDATION ON BONA FIDE[1] AND NON BONA FIDE[2] NESTS

	Bona Fide Nests		Non Bona Fide Nests	
	58	59	58	59
May	2	2	5	9
June	2	1	3	2
July	0	1	0	0
August	2	0	0	0
Totals	6	4	8	11

[1]Nests in which incubation has commenced.

[2]Singly dropped eggs and dump nests.

is covered by at least one pair. In many cases there was considerable overlapping of ranges. The magpie shows no decided habitat preference, being found in all vegetational types occurring on the area. Juveniles, as well as adults, prey on pheasant nests, and once a clutch of pheasant eggs is located the magpie continually returns until all the eggs are destroyed. Despite such an impressive list of attributes the magpie accomplished only one-third as much predation on actual nests as did its competitor, the skunk. Many of the pheasant nests located by magpies in May were singly dropped eggs or dump nests which were never incubated. Magpie predation (which was highest during this month)on these singly dropped eggs and dump nests then had no effect whatsoever on the productivity of the pheasant population. Magpies took a yearly average of 12 per cent of the eggs in the unsuccessful bona fide nests. This represented about 20 per cent of the total predation on these nests and constituted a reduction in the pheasant reproductive rate. The vegetative growth between May and June is believed to have concealed pheasant nests to such an extent that predation decreased; this in conjunction with the increased numbers of insects present and greater availability of other food is believed to account for the low magpie predation after May. Juvenile pheasant mortality was high but this was not caused by the magpie and even with all predatory factors taken into consideration, the pheasant population, by late August 1959, produced a normal young per hen ratio. The effect of the magpie on the pheasant population in the Burnt Fork area was slight and when standing alone was not a limiting factor.

Craighead and Craighead (1956) have shown that predation cannot generally be accurately evaluated by study of a single predator species, but must be evaluated with reference to the total predatory force exerted by an aggregate of predators. Thus magpie predation when considered with the predation effected by the aggregate predator populations present and operative on the area, must be recognized as an important and integral part of the total predatory force - a force which accounted for 57 per cent of all egg destruction and 70 per cent of all adult pheasant mortality attributed to known predator

SUMMARY

1. An investigation, the second phase of a long term study to determine magpie predation on pheasant eggs, was conducted in 6 square miles of the Burnt Fork Valley, 30 miles south of Missoula, Montana during 1958 and 1959.

2. Pheasant nesting studies were carried on each year to ascertain the reproductive rate and productivity of both the wild and planted segments of the population. It was believed predation by magpies could ultimately be measured by the degree it effected these factors. Comparing a total of 76 clutches for the 2 years it was found that the wild and released hens produced average clutch sizes of 10.1 and 6.7 eggs respectively. The average clutch of wild birds in the Burnt Fork area was slightly smaller than those occurring in the midwest but conformed quite closely to those found in Idaho and western Montana. Game farm birds on the study area laid smaller clutches than was the case in the midwest although the data were not strictly comparable.

3. Egg predation of bona fide nests was the most important mortality factor lowering pheasant productivity. It was twice as high as the figures quoted from the eastern half of the nation and about four times the figures quoted from Oregon and Idaho.

4. Magpie predation was observed on the wild and game farm populations during both years of the study. The magpie

was responsible for 21 per cent of the eggs destroyed by predation at the wild and game farm nests in 1958 and 20 per cent in 1959. Predation by magpies was highest during May and steadily decreased during the remainder of the season. Much of this predation occurred on singly dropped eggs and dump nests and therefor had no effect on pheasant productivity. Growth of the vegetation and its concealment of nests is believed to partially account for the drop in magpie predation after May.

5. Magpies and skunks were the most important predators of pheasant eggs. However, skunks destroyed an average of almost 36 per cent of the eggs in unsuccessful wild and game farm pheasant nests each year while magpie predation amounted to an average of only 12 per cent. Skunk predation was low in May, conversely to magpie predation, and increased by June. Skunks destroyed more pheasant eggs than did magpies in all months but May. As skunks locate nests mainly by scent, growth of the vegetation did not interfere with their success as it did with the magpies'.

6. Predation on dummy nests was studied during May and June each year and information was collected which supplemented the observations made at the wild and game farm pheasant nests. As with the wild and game farm populations, magpies and skunks were the only important predators of dummy nests. Clutch destruction by magpies was heaviest in May and decreased by June. Magpies accounted for more eggs of the dummy nests than

did the skunks. This was because the lack of incubating hens facilitated magpie predation and tended to act as a deterrent to egg destruction by skunks. In addition all adult skunks trapped were shot. Despite these factors skunk predation on dummy nests increased from May to June, just as it did on the wild and game farm nests.

7. Mowing was the most important egg mortality factor other than predation. It destroyed a yearly average of 24 per cent of all the eggs in unsuccessful nests. This was twice the egg destruction caused by magpies.

8. Pheasant brood mortality was very high, with over half the wild broods and just about half the game farm broods eliminated by the end of August. All causes of this mortality were not determined but it was established that the magpie was not responsible for it.

9. Despite what appear to be heavy losses, the 1959 August pheasant census disclosed a wild brood average of 5.6 young and a game farm brood average of 4.3 young. It may be concluded that pheasant brood sizes appear to be normal for western Montana and are comparable with data presented in the literature from Idaho.

10. The number of young per hen, based on the entire female population in late August, 1959, was 1.5. This appears to indicate that mortality factors were not excessive.

11. Brown (1957) determined the average magpie nesting density per square mile for both years to be 55.5 pairs and

found that, despite a potential 330 per cent annual rate of increase, by the time the next nesting season was reached mortality factors reduced the population to about the same level as the previous year. Potentially, the maximum predation by magpies would take place when their population density was highest, i.e., at the time the fledged young left the nest, but after this recruitment had occurred, increased cover rendered pheasant nests and eggs less vulnerable.

12. It may be concluded that magpie predation was heaviest in the early part of the nesting season, at that time largely effecting singly dropped eggs and dump nests. Egg destruction by magpies was only one-third the magnitude of skunk predation. Other than predation, mowing was the most important factor causing pheasant egg mortality. Measures of pheasant productivity and the reproductive rate indicate that mortality factors were not excessive. Magpie predation as one of these factors was important only as it contributed to the total mortality. The effect on the population by the magpie was not as great as other predators and natural regulating forces but was important in that all these mortality factors prevented the pheasant from more nearly realizing its potential.

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